Monitoring Puget Sound Forage Fish Habitat: Lessons from the Redondo Seawall Mitigation and Monitoring Project

Jim Shannon *and* ***William Taylor***
Taylor Associates, Inc.

Abstract

Objective: The purpose of the monitoring effort was to identify changes to intertidal beach habitat used by surf smelt *(Hypomesus pretiosus),* Pacific sand lance *(Ammodytes hexapterus)*, and rock sole *(Lepidopsetta bilineata)* over a five year period resulting from reconstruction of the Redondo Seawall in King County, Washington.

Methods: Monitoring occurred in consecutive years from 1996 to 2000. Five duplicate, random one liter samples of intertidal beach substrate were taken from each of three transects twice a year along the 0.6 kilometer Redonodo seawall.

Results: Substrate particle size suitable for forage fish spawning (substrate 1/16-1/4 inch in size) and fish eggs were present in each years beach substrate samples. However, the reconstructed seawall has changed the composition of substrate at all transects compared to baseline monitoring.

Significant conclusions: Intertidal forage fish spawn and beach substrate vary greatly between years and within seasons. Recommendations for future forage fish monitoring projects include: multiple years of baseline monitoring, beach profile surveys should be conducted in the spring after major winter storms have ceased and in the fall before winter storms change beach habitat, and a relationship needs to be developed between size of substrate and forage fish spawn presence.

Broader implications: A standard methodology for future forage fish monitoring projects needs to be developed so this important strand in the Puget Sound food web is better understood.

Introduction

In the fall of 1996, the King County Department of Transportation completed the Redondo Seawall reconstruction project. The Redondo seawall reconstruction project area is located in southwestern King County along the Poverty Bay shoreline near Federal Way, Washington. The project consisted of removing the original timber seawall and replacing it with a concrete seawall that reclaimed five lineal feet of intertidal beach.

The Washington Department of Fish and Wildlife identified the beach within and adjacent to the project as spawning habitat for surf smelt (*Hypomesus pretiosus*), Pacific sand lance (*Ammodytes hexapterus)*, and rock sole (*Lepidopsetta bilineata*). Mitigation and monitoring was conducted in response to requirements of the U.S. Army Corps of Engineers and other regulatory agencies. Mitigation included a 10-foot-wide band of pea gravel spread along 3,000-foot length of the seawall to augment existing forage fish spawning habitat. The quality of forage fish spawning substrate is determined by several factors, including:

(1) The amount of cobble (>1/4 inch), which is too large for fish spawning.

(2) The amount of pea gravel (1/16 - 1/4 inch), which is considered optimal for fish spawning.

(3) The amount of fines (<0.01 inch), which diminishes the quality of spawning gravel.

The goal of the five-year post-construction monitoring effort was to identify changes to intertidal habitat used by surf smelt, Pacific sand lance, and rock sole resulting from reconstruction of the Redondo Seawall. The monitoring process consisted of three objectives:

(1) Identify changes in intertidal habitat conditions (by measuring substrate particle size distribution) and changes in use of the spawning habitat (by observing the presence or absence of fish eggs).

(2) Determine whether threshold conditions have been exceeded. Conditions that indicated threshold conditions were exceeded include: (a) substrate particle size distribution has changed to the degree that it is no longer suitable for forage fish spawning, and (b) forage fish eggs are not present in beach substrate samples. Contingency actions are not warranted if threshold conditions have not been exceeded.

(3) If changes in the intertidal habitat exceed threshold conditions: (a) determine whether the changes are significant enough to render the beach no longer suitable for spawning; (b) determine if the changes are the result of seawall reconstruction, and (c) initiate contingency actions if necessary. Contingency actions were not defined because no method exists to directly measure a causal relationship between the existence of the reconstructed seawall and the condition of forage fish spawning habitat. Therefore, determining if contingency actions are warranted is based on a preponderance of evidence and on consultation with appropriate resource agencies.

Methods

Three substrate sampling transects were established, representing the north, central, and south portions of the seawall shoreline (A, B, and C, respectively). These transects are located within the upper intertidal zone adjacent to the seawall in areas with different baseline substrate composition and beach slope. Transects were reestablished at these same locations for the five consecutive post construction seasons. Each transect begins at the seawall and extends 100 feet at an oblique angle toward the water's edge from northeast to southwest.

One baseline (pre-construction) substrate sample was collected before mitigation pea gravel was spread at the base of the seawall in August of 1996. Post-construction monitoring visits were conducted in December and February. These monitoring times were selected to coincide with known spawning times of surf smelt/Pacific sand lance (December) and rock sole (February) in the Redondo area. All sampling dates occurred during a tide of less than +7.0 MLLW.

At each transect two 1-liter grab samples were collected at five randomly generated substrate sampling points along the 100 foot transect. One grab sample from each of the five substrate sampling points was combined in a 5 gallon plastic bucket to produce a 5 liter composite sample. The second, duplicate composite sample was created with the remaining five 1-liter samples from each substrate sampling point. One composite sample was delivered to the King County Materials Laboratory for analysis of substrate particle size distribution. The laboratory measured the dry weight of substrate retained on each sieve plate and expressed the results as the percentage of material passing through each sieve plate. The other received further processing in the field for forage fish spawn identification and enumeration (Pentilla 1995a, b).

Results

Surf smelt spawn was found every year at every transect except Transect C in 1998 (Figure 1). Previously undocumented Pacific sand lance spawn was found at Transects A, B, and C in 1998 and 2001 and at Transect C in 2000 (Figure 2). A small amount of rock sole spawn was observed in February of 2000 at Transect B and Transects A, B, C in 2001.

After reconstruction of the Redondo seawall dominant beach substrate size has changed from cobble to sand (0.01-1/16th inch) at Transect A (Figure 3). The same shift has occurred at Transect B (Figure 4). Transect C has seen an increase in cobble over time and a reduction in sand (Figure 5).

Conclusions

In every post-construction monitoring season threshold conditions were not exceeded. That is, substrate particle size was suitable for spawning and forage fish spawn was present in beach substrate samples.

The reconstructed seawall appears to create a depositional area at Transects A and B where sand settles out covering the cobble that dominated the transects previously during the baseline sampling. Because of this deposition sand has rapidly covered the mitigation pea gravel placed at Transects A and B. At Transect C, the dominant substrate remained cobble. Fines at Transect C decreased over time.

The reconstructed seawall does not appear to effect the spawning of surf smelt and may contribute to the previously undocumented spawning of Pacific sand lance in the area. Pacific sand lance often spawn in finer grained substrates. Variation in the number of eggs between years is believed to be the result of population dynamics of forage fish that use Redondo Beach as spawning grounds and the sample design of this study.

Recommendations

A minimum of two years of baseline monitoring should be conducted in areas where seawall reconstruction or shoreline modification is proposed. This length of monitoring will provide information on natural temporal and spatial variation in beach substrate and forage fish spawn at proposed seawall reconstruction sites. Baseline monitoring should also include an analysis of geomorphologic processes and net shore drift at specific locations.

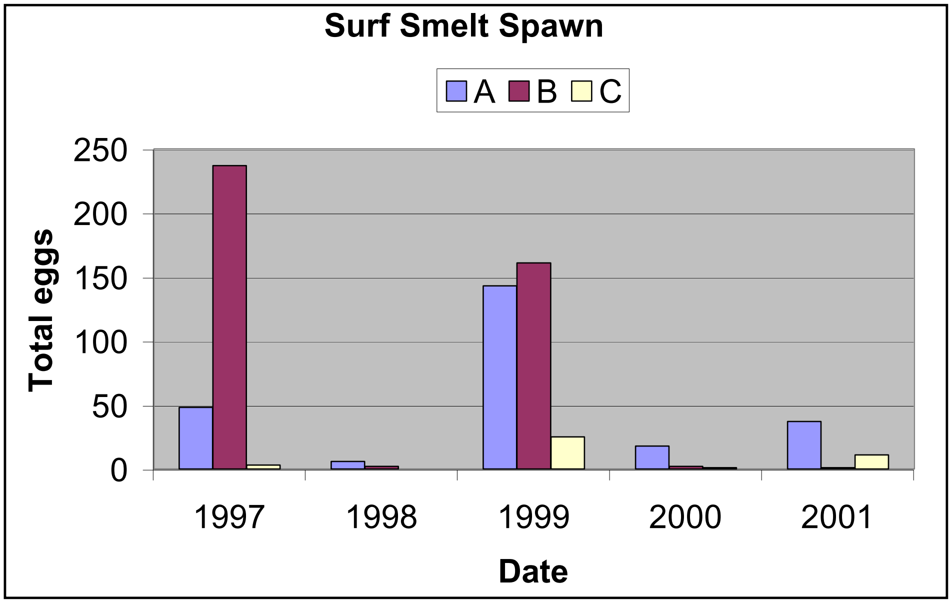

Figure 1. Surf Smelt Spawn at Transects A, B, C from 1997-2001.

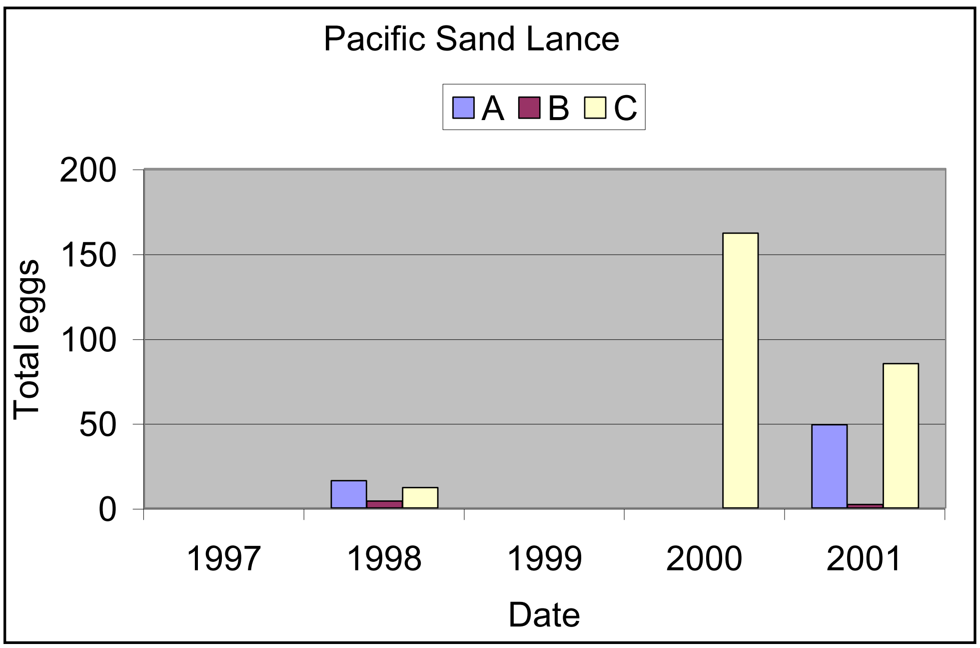

Figure 2. Pacific Sand Lance spawn at Transects A, B, C from 1997-2001.

The effectiveness of pea gravel as mitigation device for this project is undetermined. Ultimately the beach substrate composition will be determined by local substrate transport processes and wave action at the seawall. However, at the time of reconstruction it was unknown what effect the new seawall would have on beach substrate and resource managers erred on the side of caution. That is, only positive effects to fish resources were assumed as a result from pea gravel mitigation.

A beach elevation profile survey should be conducted over the length of the transect starting at the base of the seawall and ending at 0.0 MLLW. If possible, the beach profile surveys should be conducted at least two times a year. The two beach profile surveys should be conducted in the spring after major winter storms have ceased and in the fall before winter storms change beach habitat. Beach profile survey points should include, but not be limited to, the same location substrate and forage fish spawn samples are obtained. Surveying the exact location where the forage fish spawn and substrate samples are obtained will allow the development of a relationship between beach elevation, presence/absence of forage fish spawn, and substrate composition.

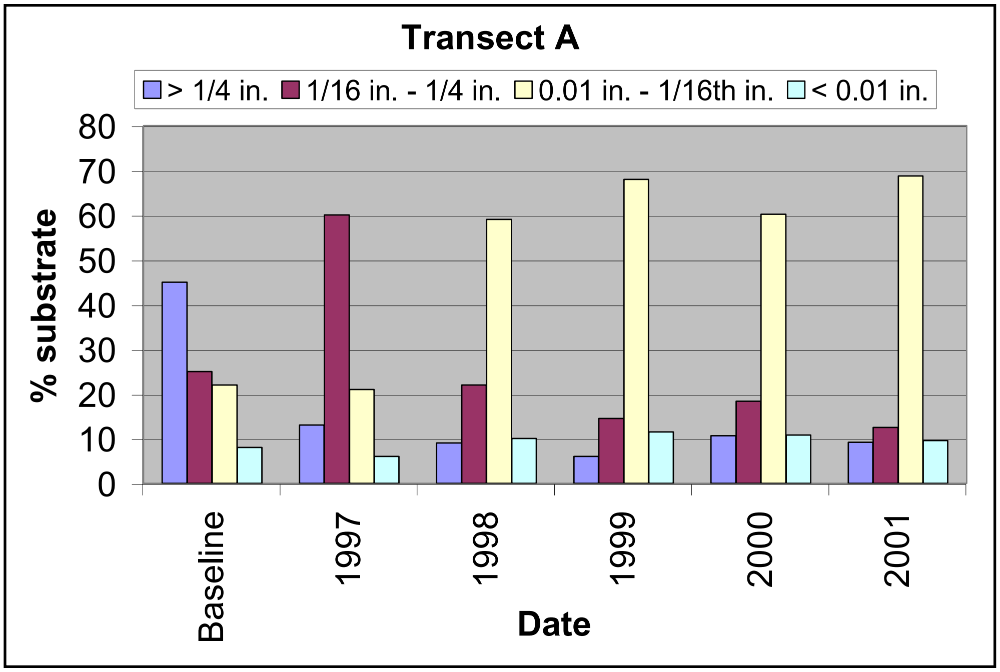

Figure 3. Transect A substrate composition (baseline plus five years post construction monitoring).

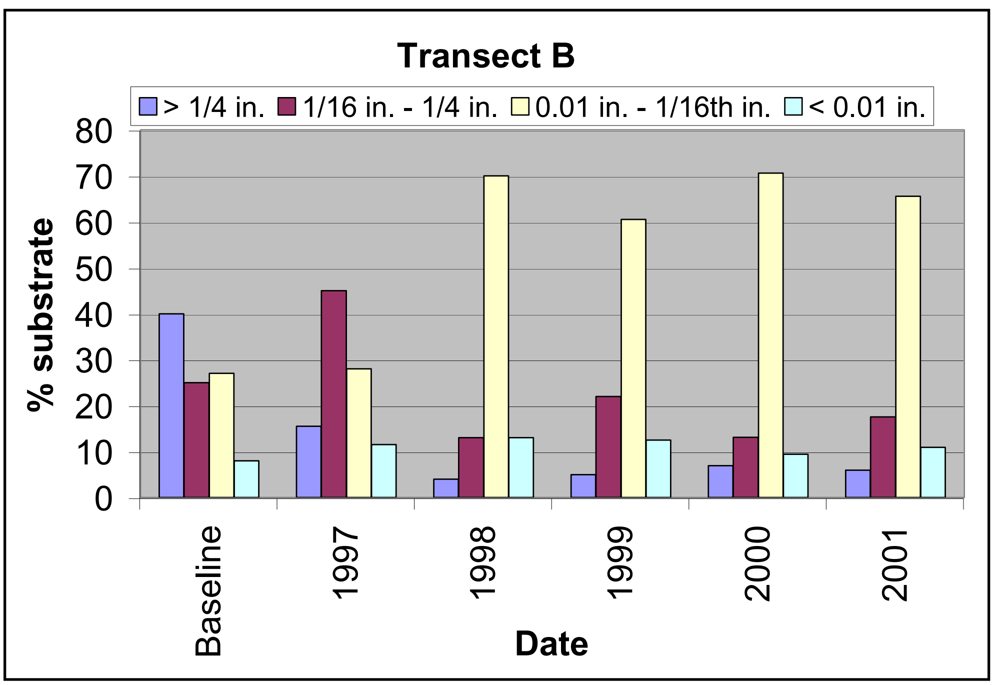

Figure 4. Transect B substrate composition (baseline plus five years post construction monitoring).

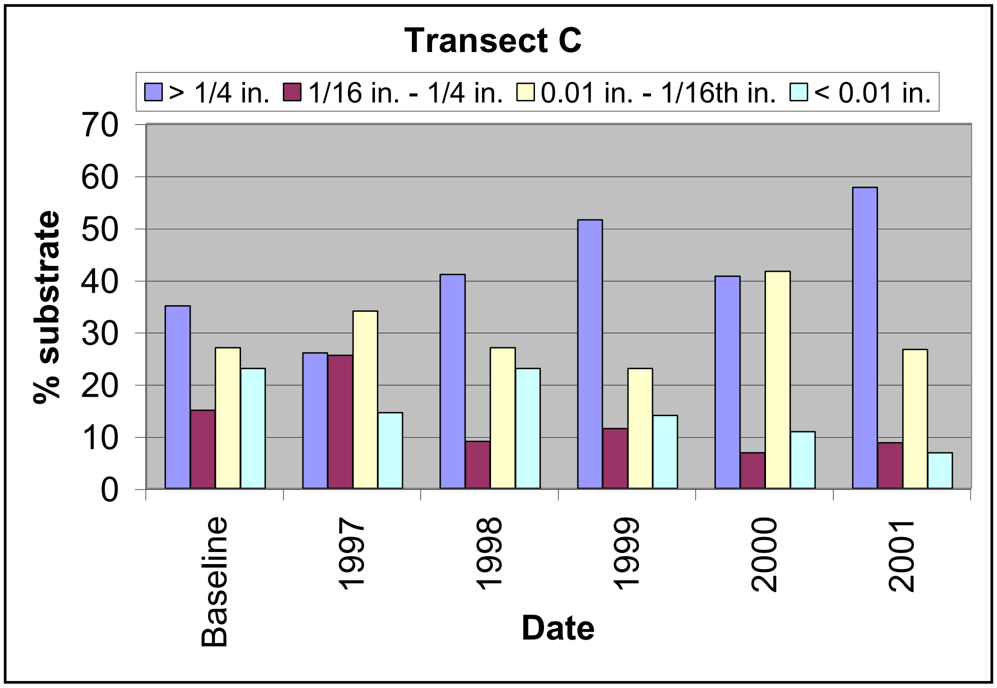

Figure 5. Transect C substrate composition (baseline plus five years post construction monitoring).

In order to compare the size of the substrate with the number of spawn found in that particular substrate sample forage fish spawn and substrate samples should not be composited. This monitoring approach will allow a relationship to be developed between size of substrate and forage fish spawn presence. Forage fish spawn should also be analyzed for stage of development of the eggs to better estimate forage fish spawn timing.

Acknowledgements

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